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The Culture of Disenchantment in Engineering Education Revealed through the COVID-19 Pandemic

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ABSTRACT

Previous research has shown that U.S. engineering programs often fail to teach students their professional responsibility to public welfare due to a "culture of disengagement." Within this culture, students primarily engage with microethics (i.e., particular issues faced by individual engineers and within the engineering profession) and less with macroethics (i.e., the role of engineers in promoting sustainability, influencing public policy, and considering the broader impacts of engineering work). Here, our study explores whether this culture persists when students experience a pressing real-world ethical issue, such as the global COVID-19 pandemic, that directly impacts their day-to-day lives. We conducted a survey of senior engineering students at a university in the Midwest. Results indicate that students are interested in ethics when presented with a problem they are currently experiencing; in this case, the COVID-19 pandemic. Students' responses to questions about the perceived role of engineers in the pandemic response included aspects of both microethics and macroethics at the individual and professional levels. However, students demonstrated disengagement from the social dimensions of macroethics. Student responses were by and large focused on improving current systems, rather than reimagining how new processes or technological improvements could address social problems such as socioeconomic inequalities exacerbated by this pandemic. That is, students focused in their thinking on how to make incremental adjustments to the status quo (e.g., improving efficiency). These results align with previous research indicating a culture of disengagement amongst engineering students and a broader lack of engagement with ethical issues at the macro-societal levels.

KEYWORDS

Engineering Ethics, Macroethics, COVID-19, Culture of Disengagement

INTRODUCTION

On a daily basis, engineers make complicated and critical decisions that directly affect the health and welfare of the public. However, many catastrophic events such as the DC-10 crash in 1974, the Ford Pinto case in 1981, the Union Carbide explosion in Bhopal in 1984, the Chernobyl nuclear accident in 1986, and the explosion of the Challenger space shuttle in

1986 led the public to pay more attention to the ethical duties of engineers (Lambrinidou and Edwards, 2013). This ultimately led to the revisions of multiple professional codes of ethics and, most importantly, the establishment of the discipline of engineering ethics (Lambrinidou and Edwards, 2013). Such engineering project failures suggests that engineers sometimes place insufficient emphasis on the protection of public health and welfare, partly due to an array of pressures (e.g. professional, organizational, financial, and political) (Lambrinidou and Edwards, 2013). In fact, previous literature has shown that engineers who do not take into account public concerns about their projects are much more vulnerable to self-interest, self-delusion, and institutional pressures that contribute to unethical and substandard decisions, leaving negative impacts on society (Lambrinidou and Edwards, 2013).

Cech (2014) argues that U.S. engineering education fails to influence students to take seriously their professional responsibility to public welfare due to a "culture of disengagement." Disengagement here refers to "bracketing a variety of concerns not considered directly relevant to the design or implementation of technological objects and systems, such as socioeconomic inequality, history, and global politics" (Cech, 2014). Such disengagement strictly defines what it means to "think like an engineer," what counts as relevant information to solve engineering problems, and how engineers evaluate the success of design outcome, leading to considerations such as public welfare to be defined out of engineering problems, "excluded from the realm of responsibility that engineers carve out for themselves" (Cech, 2014).

In addition, Bok (2006) suggests that, in addition to the technical career skills students develop within their major, institutions should also focus on developing the following social competencies: (1) learning to communicate effectively, (2) the ability to think critically, (3) building character, (4) preparing for citizenship, (5) living with diversity, (6) preparing for a global society, (7) acquiring broader interests, and (8) preparing for a career and vocational development. Yet, the existence of the culture of disengagement in engineering suggests that competencies such as living with diversity, preparing for a global society, and acquiring broader interests are missing from engineering education.

However, historically, engineering education in the U.S. has always valued technical over social or ethical competency (Nguyen et al., 2020). In fact, many engineering programs tend to ignore the ethical dimensions of technical concepts, causing students to be insensitive and indifferent to pervasive social and political issues such as socioeconomic inequality and discrimination as well as other public concerns about their projects (Bairaktarova and Woodcock, 2015; Bairaktarova and Woodcock, 2017). This missing ethical aspect of

engineering education follows students from the classroom to the real world, leading to inequitable outcomes, failure to consider public concerns or broader impacts of their projects upon society, and their absence from public policy-making process as well as political discourse (Riley, 2008).

The COVID-19 pandemic has caused devastating impacts on our society, exacerbating human suffering and upending thousands of lives. However, it is not solely a health crisis; in fact, it is a "human, economic, and social crisis" (United Nations, 2020) that requires combined efforts spanning disciplines to solve emerging social problems. Thus, the COVID-19 pandemic and the corresponding social problems that emerged represents an ongoing real-world social issue. We hypothesize that the culture of disengagement might be most apparent when engineering students are presented with such an issue.

BACKGROUND

U.S. engineering education often values teaching scientific and engineering concepts while overlooking social implications of these concepts (Nguyen et al., 2020). This can result in students being less sensitive or even indifferent to pervasive social and political issues such as socioeconomic inequality and discrimination or community concerns during project implementation or operations (Bairaktarova and Woodcock, 2015; Bairaktarova and Woodcock, 2017). Unfortunately, this lack of focus on ethics follows students from the classroom to practice, leading to inequitable project outcomes, failure to consider public welfare issues or broader impacts of projects upon society, and an absence from public policy-making process as well as political discourse (Riley, 2008; Nguyen et al., 2020). For instance, an engineering project aimed at improving infrastructure within a refugee camp by the United Nations (UN) required engineers to recognize the needs and perspectives of the refugees in this camp towards the project (Gabiam, 2016). The project faced resistance from some refugees because they felt that the UN had already given up on helping them return to their home country. This is because refugee camps are designed to be temporary; but improvements in camp infrastructure meant, to the refugees, that they are likely to stay for much longer. They thus felt abandoned. This example illustrates a complicated and interdependent relationship between technical and ethical aspects of engineering work. Engineers made the mistake of ignoring the attitude of refugees towards their project, and thus fail to provide the best solutions to help these refugees.

Cech (2014) found students to be less engaged with topics they consider "not relevant" to the design or implementation of technology, such as racial inequalities, at the end

of their engineering studies when compared to the beginning, suggesting that the culture of disengagement is fostered throughout the engineering curriculum (Cech, 2014). Within a culture of disengagement, students primarily engage with microethics and the professional aspect of both microethics and macroethics; that is, they engage less with the social aspect of macroethics. Microethics includes two distinct levels--the individual and the professional. Individual level microethics refers to the actions of individual engineers, while professional microethics refers to relationships between individual professionals and their clients, colleagues, and employers (Herkert, 2001). Macroethics also includes two different levels--the professional and the social. Professional macroethics refers to the problems confronting members of the engineering profession as a group in their relation to society while social macroethics refers to the technology policy decisions at the societal level (i.e. the social relations of expertise in connection with technological management and decision making) (Herkert, 2001). The relationships between individual ethics, professional microethics, professional macroethics, and social macroethics are illustrated in **Figure 1**.

In addition, Cech (2014) argues that there are three underlying ideological pillars within this culture of disengagement, namely depoliticization, technical/social dualism, and meritocracy. The ideology of depoliticization suggests that engineering work could and should be separated from social and political concerns because such considerations might lead to bias in engineering practice. A technical/social dualism has the effect of devaluing social competencies (e.g. public welfare considerations are not valued because they are on the social end of the dualism). Lastly, meritocratic ideology suggests that existing social structures in the U.S. are fair and just. Together, these suggest that topics like public policy-making and addressing unemployment or socioeconomic inequalities are considered "irrelevant" to the job the engineers because: (1) they can introduce biases to the work of the engineers, (2) they make the engineers seem technically "incompetent," or (3) the existing social structures are working fine. This gives rise to narratives such as "engineers should stick to building things", "chemists should stick to synthesizing drugs", or "doctors should just stick to treating patients". These are the kind of narratives that the concept of the culture of disengagement criticizes. However, we take the stance that engineers should be involved in public policy-making processes regarding the use of technologies instead of relying solely on non-technical experts.

Previous work has also identified that institutional level drivers, such as institutional ethical culture, play a significant role in promoting ethical behavior (Nguyen et al., 2020). Institutional ethical culture describes the role of professional institutions such as engineering

schools and departments in regulating the practice of engineers in a well-ordered society (Brosnan, 1996; Bucciarelli, 2008; Stovall, 2011; Holsapple et al., 2012; Burt et al., 2013; Nguyen et al., 2020). In the context of engineering ethics, institutional ethical culture describes the beliefs, habits, and values of the engineering school in the context of the institution as a whole that influences student understanding of ethics (Holsapple et al., 2012; Burt et al., 2013; Nguyen et al., 2020). Institutional ethical culture is, indeed, essential because it sets the standards for the field of engineering (Bucciarelli, 2008). In order to understand the institutional ethical culture and how it aids in the process of ethical decision making, three factors of institutional ethical culture should be considered, namely institutional values, organizational context, and peer environment (Nguyen et al., 2020).

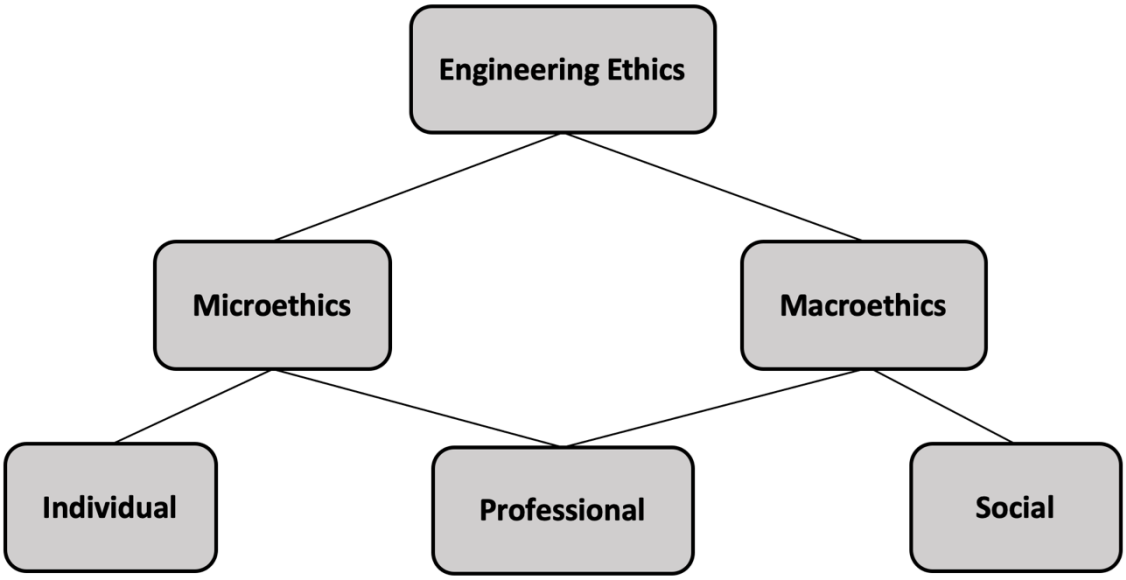

Figure 1: The relationships between individual ethics, professional microethics, professional macroethics, and social macroethics (Herkert, 2001).

Institutional values in this context represent the collective values of the students' institutions (Cech, 2014). Cech (2014) suggests that commitment to public welfare concerns is not highly valued in students' engineering professional identities and that this commitment decreases over the course of their undergraduate studies (Cech, 2014). As such, collective institutional values do seem to affect students' ethical awareness and that these values do place an emphasis on technical background over an ethical or social background. Organizational context, on the other hand, describes the formal organizational structures, academic and institutional priorities, mission, and ethos as well as faculty culture (Lynch and Kline, 2000; Conlon and Zandvoort, 2011; Holsapple et al., 2012; Finelli et al., 2012; Cech, 2014; Nguyen et al., 2020). In reality, the majority of engineers work in an environment where their freedom to make decisions is restricted by the corporate or organizational culture

(Lynch and Kline, 2000; Conlon and Zandvoort, 2011). Thus, a disengagement culture is embedded within the broader culture of U.S. engineering and materializes at the organizational level in many engineering educational programs (Cech, 2014). Indeed, some studies suggest that accidents might be better understood as a result of organizational failure rather than individual error or technical failure--i.e., the analysis of accidents should be examined through historical background and organizational context (Lynch and Kline, 2000; Conlon and Zandvoort, 2011; Nguyen et al., 2020). Lastly, peer environment represents student characteristics, values, attitudes, beliefs, and behaviors (Holsapple et al., 2012; Finelli et al., 2012; Nguyen et al., 2020). The students' individual experiences within an institutional culture may vary largely even though there is a shared peer environment within that culture (Holsapple et al., 2012; Nguyen et al., 2020). Individual students within an institution are exposed to these institutional factors and, as such, these factors aid in shaping their ethical behavior. From this, we can draw the conclusion that if an institution favored teaching technical knowledge over ethics, their students would most likely be disengaged from ethical aspects of engineering works.

Literature on macroethics in engineering has indicated a lack of focus on students' macroethical sensitivity (Nguyen et al., 2020). At the same time, the general public seems to believe that many engineers are not sufficiently engaged in societal and community concerns (Canney and Bielefeldt, 2015a; Canney and Bielefeldt, 2015b). This shows that the field of engineering and engineering education need to engage more with macroethics at the societal level by focusing on how engineers reflect on and evaluate their social responsibilities regarding technological advancement (Gunckel and Tolbert, 2018; Nguyen et al., 2020). In general, more work is needed in the area of engineering macroethics to develop integrated approaches that address both micro and macro issues in engineering--i.e., there is a need to link personal professional ethics with social professional ethics (Nguyen et al., 2020). Research should focus on addressing this culture of disengagement in relation to a lack of macroethical sensitivity as this culture could have detrimental consequences.

It is possible that this culture of disengagement is linked to diverse microaggressions (the subtle and stunning assaults that people face because of their membership in social groups such as race, gender, and sexual orientation) that minority engineering students experience on a daily basis (Poleacovschi et al., 2019). Indeed, a study on microaggressions in engineering showed that assumption of criminality and ascription of intelligence are the two most frequently experienced microaggressions by Black engineering professionals (Poleacovschi et al., 2019). In addition, it is possible that this culture of disengagement acts

partly to enhance racial bias and allow it to remain implicit, unnoticed, and hidden by the more overt institutional enthusiasm for nurturing publicly and politically engaged future engineers. Cech suggests that this culture of disengagement among engineering institutions might even be deeply embedded within the broader U.S. engineering culture. This culture of disengagement manifests itself at the organizational level of engineering education programs, even when these programs introduce social justice concepts and practices directly into their curricula (Cech, 2014). Whether this culture of disengagement is present when students are presented with an ethical issue directly impact them, such as the global COVID-19 pandemic, needs further investigation.

METHOD

To test the above hypothesis that the culture of disengagement might be apparent when students are presented with such an issue, we surveyed graduating engineering students' perception of their role as engineers during the COVID-19 pandemic in order to see whether the culture of disengagement manifests itself in students' responses (N=165). The survey sought to understand recurrent themes in the students' responses. From this survey, two questions (open-ended) are of interest:

1) *What are some ways that engineers could address the COVID-19 pandemic? Please explain.; and*
2) *How important is it that engineering classes focus on challenges in today society, such as the COVID-19 pandemic? Please explain.*

The first question attempts to capture students' ability to address social problems such as socioeconomic/racial inequalities exacerbated by this pandemic using technical expertise. We looked for different aspects of microethics and macroethics provided in **Figure 1** and emphasis on these social problems (e.g., redesign manufacturing processes in response to inequalities of access to PPE). The second question was designed to examine to what extent students are interested in ethics and emphasized social aspects. In combination, the two questions indicate the extent to which students are interested in ethics and how prepared they are to address real world ethical problems such as the COVID-19 pandemic. A lack of emphasis on social aspects in their answers confirms the presence of the culture of disengagement.

RESULTS

We found that students most frequently (51%) suggested that engineers could address the pandemic by designing more efficient systems/machines to produce products that can be useful during the pandemic, such as personal protective equipment (PPE) (**Table 1**). The frequency percentages were rounded to two decimal points for all tables. For example, one student responded:

> "If there's any way to streamline the manufacturing of necessary products, such as ventilators, I think that's an important task that engineers can help with. Also, any new machinery that could benefit as well, whether that's a machine for sanitation or anything else."

In general, the responses in this category tend to focus heavily on applying engineering concepts and techniques to come up with new and better designs or treatments. For example, a student responded:

> "Implementing new designs and treatments to inexpensively combat the virus, such as cheaper face shields. Generally speaking, using the technical and problem-solving skills associated with an engineering degree to solve the problems presented."

These responses revealed that they were focusing on improvements on existing processes instead of suggesting new ways of addressing the problems associated with technological policy decision making; for example:

> "They could help design and manufacture new masks, ventilators, and drugs to use during the pandemic."

There is no mention in these comments of the social aspect of macroethics (technological policy decisions at the societal level) even though the responses discussed the problems confronting members of the engineering profession as a group in their relation to society.

Table 1: Coded responses to the question *What are some ways that engineers could address the COVID-19 pandemic?*

#	Different Ways Students Think Engineers Should Engage with Public Welfare During the COVID-19 Pandemic	Response (%)	Response Frequencies
1	Designing more efficient systems	51.45	124
2	Complying with public guidelines	14.52	35
3	Supporting health care professionals, essential workers, or others	9.96	24
4	Finding a cure	6.64	16
5	Providing facts/models/policy recommendations	5.81	14
6	Encouraging discussion on safety measures	3.73	9
7	Working together/forming organizations	2.07	5
8	Unsure	1.66	4
9	Being an advocate/activist for change	1.24	3

10	Continuing to address global issues	0.83	2
11	Finding ways to help post epidemic	0.83	2
12	Continuing working	0.41	1
13	Avoid helping/only providing help if having the skills/resources	0.41	1
14	Keeping up-to-date with the company	0.41	1
	Total		241

In response to question *"How important is it that engineering classes focus on challenges in today society, such as the COVID-19 pandemic?",* about 75% of the participants believe that it is very important that engineering classes focus on challenges in today's society (**Table 2**). Among the reasons stated by those who think that it is very important that engineering classes focus on challenges in today's society, 53% of responses were coded to "engineers must be resourceful and adaptable" and 24% of responses were coded to "they can provide real world experience/application/preparedness" (**Table 3**). For example, one student responded:

> "It is very important to be educated in engineering ethics and also to be prepared for uncertain circumstances such as in a pandemic. Engineers are trusted to be resourceful and adaptable."

Another responded:

> "Very important because unusual situations will likely always come up so if we have practice of overcoming challenging situations, we will be better equipped when it will happen."

Here, the students focused on microethics regarding how prepared they are to enter the engineering profession and become successful.

Table 2: Response summary to the questions *How important is it that engineering classes focus on challenges in today's society, such as the COVID-19 pandemic?*

#	How important it is for classes to focus on challenges of today society	Response (%)	Response Frequencies
1	Very important	75.66	115
2	Fairly important	13.82	21
3	Little important	3.95	6
4	Not important	3.29	5
5	Unsure	3.29	5
	Total		152

Table 3: Coded responses to the question *How important is it that engineering classes focus on challenges in today's society, such as the COVID-19 pandemic?*

#	It is very important for classes to focus on challenges of today society because	Response (%)	Response Frequencies
1	Engineers must be resourceful and adaptable	52.79	123
2	Engineers provide real world experience/application/preparedness	24.03	56
3	Engineers should help the society/communities	5.15	12
4	Engineers provide different perspectives	4.72	11
5	Engineers need to be able to think creatively/solve problems	3.43	8
6	Engineers help better understand in-class concepts	1.28	3
7	Students are more open to learning new materials than professional engineers	0.86	2
8	These challenges affect everyone	0.86	2
9	Engineers should be required to learn ethics	0.86	2
10	The challenges make classes relevant	0.86	2
11	The challenges are related to personal challenges	0.86	2
12	The field of engineering need to focus more on ethical issues	0.86	2
13	Engineers must stay up-to-date	0.43	1
14	The challenges can cause permanent changes to society	0.43	1
15	Engineers should listen to recommendations from other non-engineering professionals	0.43	1
16	They help develop a sense of morality	0.43	1
17	They help students realize how dependent they are	0.43	1
18	Students will learn to cooperate despite political differences	0.43	1
19	That is what engineers are for	0.43	1
20	The world is rapidly changing and education cannot keep up	0.43	1
	Total		233

Among those responses that indicated that it is fairly important for classes to focus on challenges of today's society, "engineering concepts are more important" was the most coded response (58%, **Table 4**). For instance,

> "I think that the fundamentals of each engineering practice are still much more important to learn. But knowing how to consider a number of different challenges facing society could help make a more successful and conscientious engineer."

Here, one can see the manifestation of a technical/social dualism, one that compartmentalizes the technical from the social and in the process devalues the social.

Table 4: Coded responses to the questions *How important is it that engineering classes focus on challenges in today's society, such as the COVID-19 pandemic?*

#	It is fairly important for classes to focus on challenges of today society because	Response (%)	Response Frequencies
1	Engineering concepts are more important	58.97	23
2	It is important only if these classes are relevant	10.25	4
3	Engineers' jobs still need to be done	5.12	2
4	It is more important in upper classes	5.12	2
5	Pandemic will not last long	2.56	1
6	It is fairly important to look at real-world examples	2.56	1
7	Internships are better for gaining real-life experience	2.56	1
8	Social responsibility is often common sense	2.56	1
9	Engineers cannot solve all problems	2.56	1
10	Engineering already has tie-ins to societal problems	2.56	1
11	Engineers must be adaptable	2.56	1
12	Students need to be aware of prevention methods to decrease exposure to the virus	2.56	1
	Total		39

Amongst those who believe that it is of little importance for classes to focus on challenges of today's society, "Focusing on the worst-case scenario can brew fear/paranoia" was the most coded response (64%, **Table 5**). As an example, one student stated:

> "To some extent, maybe? I feel like focusing on the worst-case scenario situation can brew fear and paranoia. However, having a plan of some sort for these types of situations could be beneficial. I think it would just need to be walking a fine line between the two sides."

This student perceives the current social structure as working well for everybody so that one does not need to adjust these structures. In addition, the answer shows little engagement with the social aspect of macroethics. Meritocracy is the idea of viewing the current existing social and political structures as fair and just (Cech, 2014). Those with meritocratic tendency tend to believe that capitalism, as an example, is a fair system and does not create social stratification or inequalities even though its critics argue that it does so. In other words, the meritocratic tendency is seen in terms of perceiving the existing structures as fair and just enough that it is unnecessary to think about the social issues emerging from it.

Table 5: Coded responses to the questions *How important is it that engineering classes focus on challenges in today's society, such as the COVID-19 pandemic?*

#	There is <u>little</u> importance for classes to focus on challenges of today society because	Response (%)	Response Frequencies
1	Focusing on the worst-case scenario can brew fear/paranoia	63.63	7
2	Focusing on a few challenges will not prepare students for their career	9.09	1
3	It takes away the main purpose of the class	9.09	1
4	It is difficult to fit into the curriculum	9.09	1
5	Teaching skills to be adaptable is more important	9.09	1
	Total		11

Selected respondents indicated that all events/challenges are different and that learning from one does not necessarily help in preparing for another (**Table 6**). For example:

> "In the overall picture regarding an engineering student's learning experience, I do not believe a focus on such an event will help to better prepare for the future. Teaching students of what was done for this event will not effectively prepare them for the possibility of another event that can have a completely different nature to it."

Reevaluating the historical context of the pandemic could prove useful in preparing for future pandemics. In this response, the historical context is considered less important. This answer illustrates the technical/social dualism as it devalues the historical contexts of previous pandemics which might be useful in future events.

Table 6: Coded responses to the question *How important is it that engineering classes focus on challenges in today's society, such as the COVID-19 pandemic?*

#	It is <u>not</u> important for classes to focus on challenges of today society because	Response (%)	Response Frequencies
1	All events/challenges are different	40.00	2
2	Engineering concepts are more important	20.00	1
3	Engineers should focus on past events	20.00	1
4	Problems must be solved objectively and systematically	20.00	1
	Total		5

DISCUSSION

The results indicate that students are, indeed, interested in ethics when presented with a real-world problem that they are experiencing, specifically the COVID-19 pandemic in this study. Students provided several engineering focused answers that included aspects of both microethics and macroethics, at the individual and professional level. "Supporting healthcare professional/essential workers/others" and "providing facts/model/policy recommendations"

occurred with a combined frequency of ~15% (**Table 1**). We observed some basic macroethical thinking, and an interest in thinking about societal impacts. Students are interested in contributing to the societal good by improving existing systems. In general, students seemed to show interest but indicate a disengagement from the social dimensions of such a problem. In regards to the responses to the question *"What are some ways that engineers could address the COVID-19 pandemic?", students* tended to focus heavily on applying engineering concepts and techniques to come up with new and better designs or treatments.

However, two indications led us to conclude that the culture of disengagement is, indeed, present among the surveyed engineering students. First, the responses showed that students primarily demonstrate microethical and professional macroethical level thinking, without consideration for broader societal applications of their engineering concepts to solve social problems. The lack of social sensitivity might contribute to the culture of disengagement in U.S. engineering. Second, there were manifestations of the three ideological pillars, discussed by Cech (2014), of the culture of disengagement. We observed a devaluation of social competencies, as well as meritocratic tendencies in students' responses. In addition, the results suggest that students focused heavily on technical or "real" engineering work such as designing better machines or systems with minimal considerations for "non-technical" concerns, indicating that this is a manifestation of the ideology of depoliticization.

Notably, it is a positive sign that ~75% of students thought that it is very important for engineering courses focus on challenges of today society (**Table 2**); indeed, these students showed an interest in ethics because "engineers should help the society/communities" and "they provide different perspectives" were among the more frequently mentioned themes (**Table 3**). Yet, the top two most mentioned themes among those who think that it is very important for classes to focus on challenges of today's society are "engineers must be resourceful and adaptable" and "they provide real world experience/applications/preparedness" which indicate that they are focusing primarily on achieving their own professional goals, rather than really focusing on the challenges of today's society. For example, one student responded:

> "It is important because as an engineer, we will have to learn to deal with adversity in our careers, which the coronavirus is a great example. This has never really happened before, so by teaching engineers how to respond or even just telling them this is their time to shine would go a long way."

Here the student implies that when others face a challenge it is an opportunity for an engineer to grow personally and professionally. Society's challenges are regarded primarily as a means to the individual's goal of personal and professional development.

In combination, the responses to both questions support our hypothesis that the culture of disengagement might be most apparent when students are presented with a real-world ethical issue, i.e. the global COVID-19 pandemic here in this study, that directly affects their day-to-day lives. The majority of the responses to both questions display a lack of interest in more broadly social questions, such as how engineers could use their technical knowledge to engage with or influence policy-making process to address current sociopolitical or socioeconomic issues caused by the pandemic. As Cech (2014) suggested, this disengagement from public or political discourse might lead students (and possibly professional engineers) to remain silent on these issues, instead of bringing their expertise to bear on such discourse.

One question remains: where does institutional ethical culture fit into this narrative? One could suggest that institutional ethical culture might possibly contribute to the culture of disengagement because an individual's behavior is restricted by the culture of the institution (Nguyen et al., 2020) and because students are often less engaged with ethics at the end of their engineering studies than they were at the beginning (Cech, 2014). For example, professors' attitudes towards the importance of teaching ethics are also important in shaping students' ethical behavior. Additionally, even though many faculty members assumed that their role-modeling of ethical behaviors is an important part of engineering ethics education, students did not perceive it in the same way (Holsapple et al., 2012; Nguyen et al., 2020). Therefore, unethical behaviors by some faculty and the disengagement from social aspects of the culture of institutions seem to overshadow the positive ethical behavior that students witness, despite the intentions of many faculty members to become role models for their students (Holsapple et al., 2012; Nguyen et al., 2020).

The results suggest that the majority of surveyed students showed what psychologists describe as conventional moral reasoning (Kohlberg, 1984). At this conventional level or moral development, students tend to assume the moral standards of valued adult role models, such as professors, and their reasoning begins to adopt the norms of the group or the institution to which they belong (Kohlberg, 1984). In this case, the students' responses to the question *"What are some ways that engineers could address the COVID-19 pandemic?"* suggest that they concerned mostly with already existing systems rather than thinking outside of the box.

Unfortunately, some students saw using engineering knowledge to help society as idealistic. One student, when asked about different ways to address the COVID-19 pandemic, responded:

> "Don't. The thought that all human life being something sacred that must be protected at all costs is idealistic and naive. How are we to progress as a species if everyone is forced to succeed in the most basic requirements of life without struggling on their own. A virus or plague is natural and has many beneficial long-term effects that will make any population exposed to it stronger in the long run. As individuals we have a responsibility to help our family and our community, but not necessarily to help society as a whole, at least in the context of a natural occurrence."

Finally, institutional ethical culture is important in shaping the ethical development of individual students. However, students are less concerned with ethics at the end of their engineering studies than they were at the beginning (Cech, 2014). This suggests that the culture of the institution could very likely contribute to the culture of disengagement in engineering students.

CONCLUSION

Our survey revealed an interest among students in thinking about professional ethics as well as some basic microethical thinking. Students are often interested in contributing to the societal good but their answers focused on improving existing systems. That is, students are not considering how to use their skills to address social concerns. Instead, they focus primarily on how to improve production processes such as that of PPE (i.e. efficiency).

A social focus yet often still views societal challenges primarily as opportunities for personal and professional advancement raises fascination. First, is this instrumental view of society, one that focuses primarily on capitalizing on the challenges that others face, a product of age, education, field of study, or something else? Second, how can such an instrumental view of society become refocused on the ethical dimensions of social problems instead?

As global interconnectedness and development are making their ways into the most remote corners of the world at the highest speed, the role of engineers in addressing existing social problems, such as those caused by global pandemic, is now more important than ever before. While more work is required to conceptualize what public oriented and engaged engineering work should look like, our results indicate that engineering programs should focus on teaching engineering ethics and current sociopolitical affairs to students along with

technical materials, encourage students to participate in on-campus student organizations whose missions are to promote stronger public welfare commitments, and, lastly, reexamine and rethink their institutional ethical culture in order to identify current teaching practices that might contribute to the culture of disengagement in the field of engineering.

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